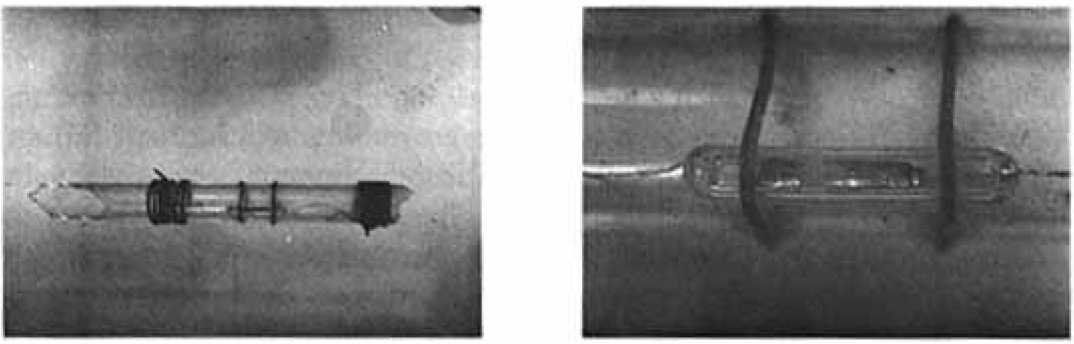
COMITATO GUGLIELMO MARCONI INTERNATIONAL

Guglielmo Marconi
The Coesor or Coherer and the antenna

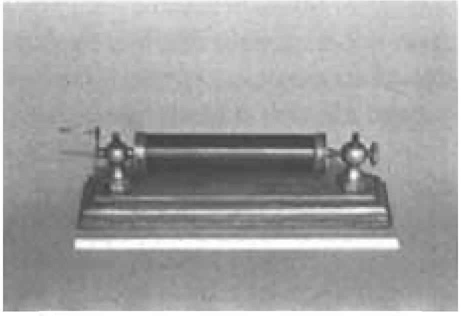
Guglielmo Marconi

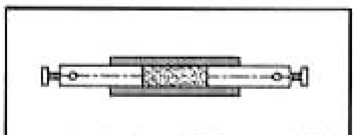


Coherer: Type of coherent Marconi 1894

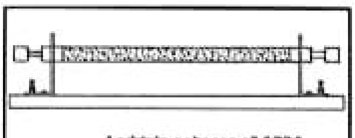
Coherer found in 1919 in a pile of debris at the Villa Griffone in Pontecchio. since in that place Marconi in the following years had no more occasion to make prolonged stops, this coherer must have been built by him, and probably discarded, before his departure for England, at the beginning of 1896. It is quite similar to a second copy which is exhibited in a Stockholm museum with the indication (Coherer di Marconi of 1896) and which was actually used. The small detector, which one of the two figures reproduces enlarged, has rheophores welded on the glass and silver electrodes with a small amount of filings, which do not show any oxidation.

Note the lack of the tang to evacuate the air before the flame closes.

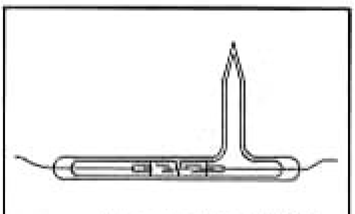




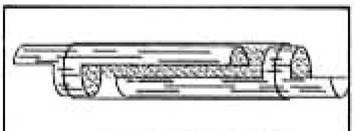
Branly's original coherer, 1890.



Lodge's coherer of 1894.



Marconi's coherer of 1895.



Popov's coherer of 1895.

Different Coherers compared:
Temistocle Calzecchi Onesti, Branly, Lodge, Marconi, Popov .
(The images do not correspond to the real size of the objects)

From the Conference pronounced by Guglielmo Marconi on 2 March 1899 in London at a meeting of the Institution of the Electrical Engineers.

"Wireless" telegraphy "or telegraphy through the wireless connection space is a topic that has attracted a lot of attention since the results of my first experiences in this country were announced. I do not propose this evening to exhibit my ideas or to discuss the theory of the system on the basis of which I have done so many tests, and thanks to which I have realized various systems, I would like instead to submit to you precise information about what has been done by me and my collaborators in these last twelve months, as well as some secure data relating to the means I used to obtain these results. Much has been written on this subject, with greater or lesser accuracy,and I do not believe that any of those present are completely unaware of the general characteristics of the system.

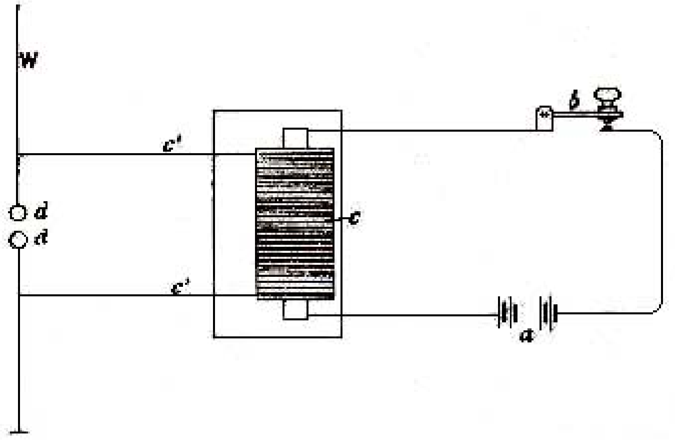
Before going into my exposition, I wish to state that every success I achieved in the practical application of wireless telegraphy is due in large part to the precious collaboration of my assistants.

I believe, first of all, that we should briefly describe the appliances.

Transmitter - If we want to overcome great distances and if it is not necessary for the signals to be transmitted in only one defined direction, I use a device for the transmission, illustrated by figure 1, in which two small spheres, connected to the ends of the secondary of a coil induction, they are connected one to the earth and the other to a vertical conductor*W* , which I will call plane.

If instead it is necessary to direct the beam of rays in a given direction I prefer to make use of a device similar to the Righi oscillator, placed along the focal line of a suitable cylindrical parabolic reflector *f* . (figure 6)

The transmitter works as follows: when key b is pressed, the battery current operates the spool *c* , which loads the spheres of the Righi oscillator or the vertical conductor W, which in turn is discharged through the spark gap.



(Figure 1)

The discharge is oscillating, and the system of the spheres and the insulated conductor behave like a radiator of electric waves. As it is easy to understand, lowering the key for short or long intervals, one can emit short or long succession of waves, which, influencing the receiver, produce short or long effects in it, according to their duration, thus allowing the playback of Morse signals or other signals emitted by the transmitting station.

Receiver - One of the main elements of my receiver is the sensitive or coherent tube, discovered, I believe I am right in asserting it from Prof. Calzecchi-Onesti of Fermo, perfected by Branly and modified by Lodge and others. The only type of cohesive, which I have found to be safe and efficient for long-distance transmissions, is the one designed by me and illustrated in Figure 3. It consists of a small glass tube, 4 centimeters long, in which they are introduced and fixed two metal poles j1 and j2. These poles are separated from each other by a small space, partially filled with a mixture of nickel and silver filings. This coherent is inserted in a circuit of which a battery and a sensitive telegraphic relay are part, in turn inserted in another circuit of which part a vibrator or "decooesor" p and a recording apparatus h.

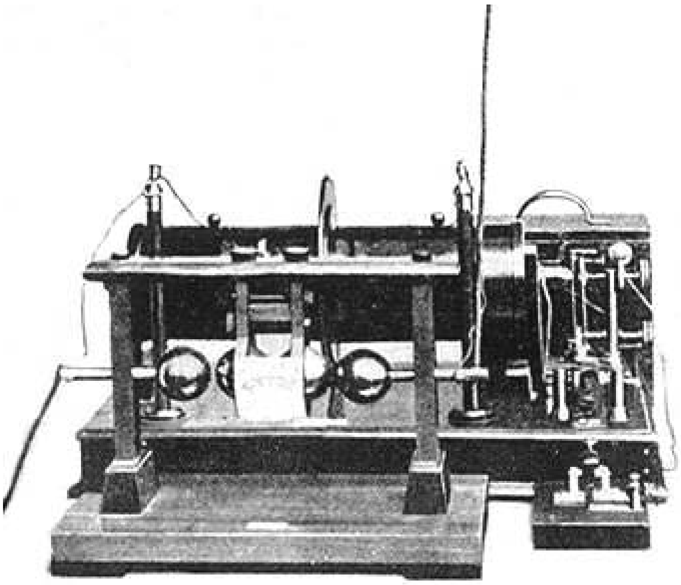
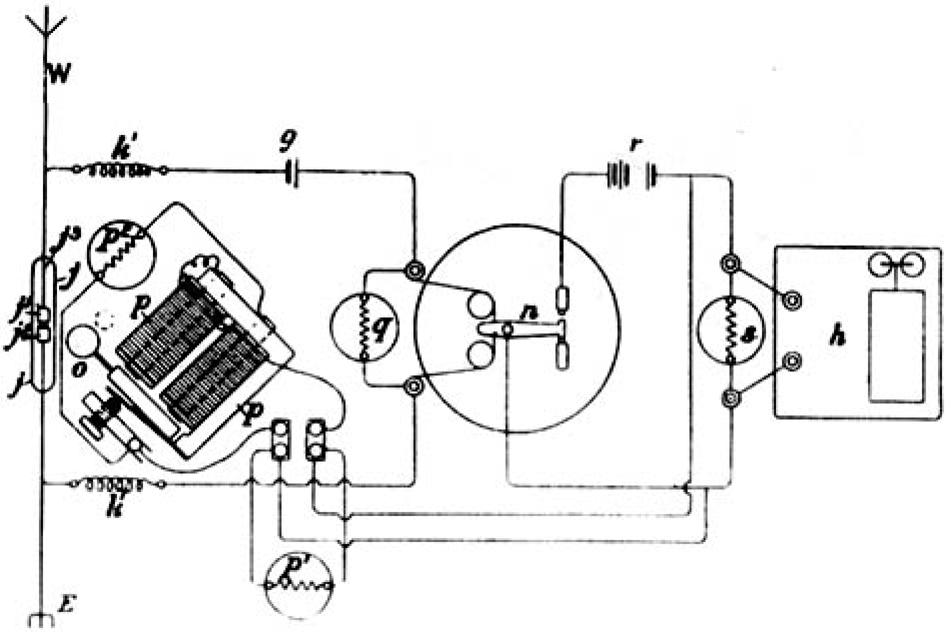


Fig. 2.

(figure 2)

In normal conditions the resistance of the filings in the infinite tube, or, in any case very large, but if said filings are subjected to the action of electric waves or pulses, a phenomenon of cohesion is instantaneously produced there and the resistance is lowered to 100-500 ohm. This allows the battery current g to operate the relay n.



(figure 3)

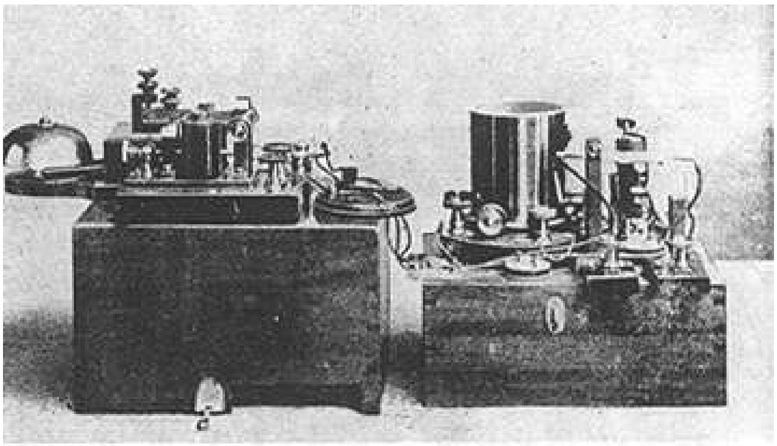


Fig. 4.

(figure 4)

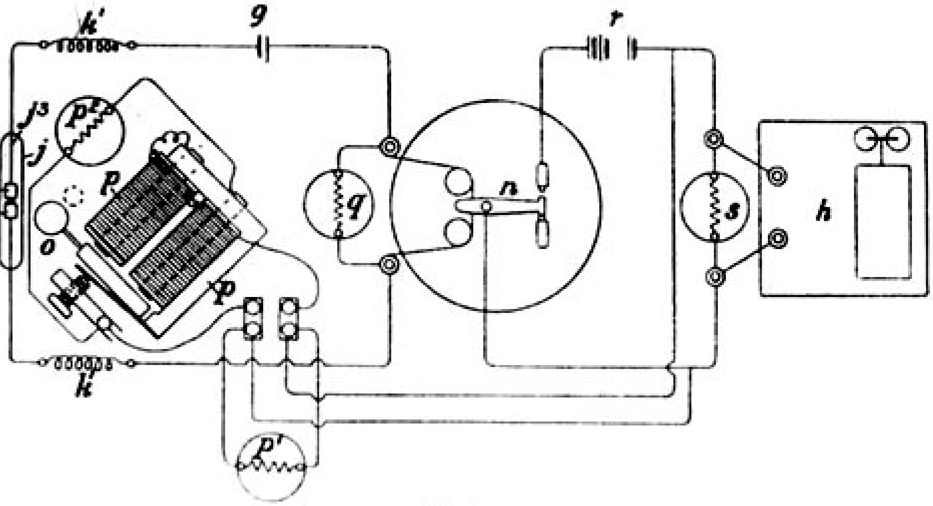


Fig. 5.

(figure 5)

One end of the tube is connected to the ground, the other to a vertical conductor similar to that of the transmitter. (figure 1) If instead the reflectors are used, a short strip of copper and connected to each etremo. (figure 6) The length of these strips must be determined exactly since good results cannot be obtained if their dimensions are not such as to produce the exact harmony or agreement with the transmitted oscillations.

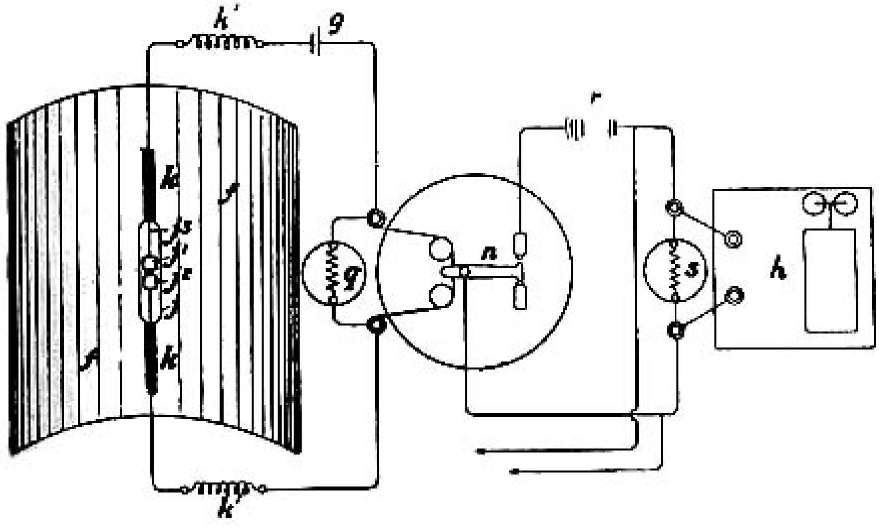


Fig. 6.

(figure 6)

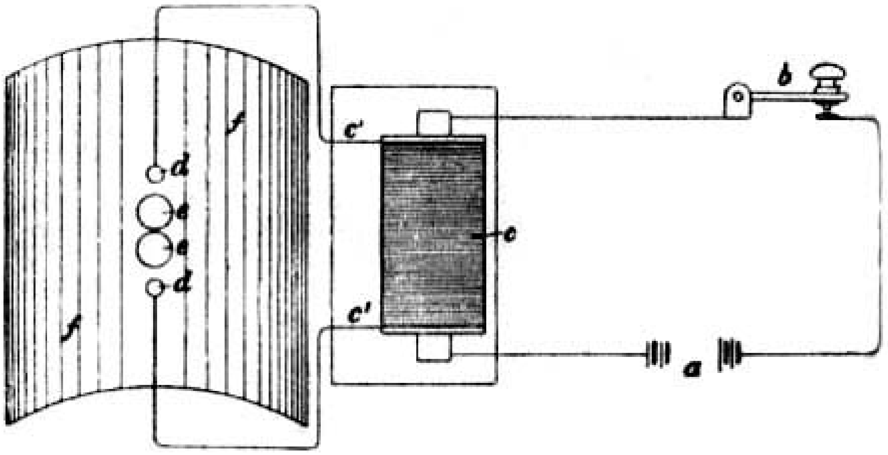


Fig. 7.

(figure 7)

All of the receiver's electro-magnetic devices have anti-inductive resistances in parallel so that there are no sparks on the contacts and sudden disturbances or pulses produced by the local battery current near the coherent.

I have found that if such resistances are lacking, there are disturbances, which prevent the coherer from regaining its sensitivity after receiving the electric oscillations.

This drawback does not occur if these resistances are used, and I attribute, to a great extent, to their action, the successes achieved with this system.

Small chokes K and K 'are inserted between the coherer and the relay. They force the oscillating current, due to electric waves, to cross the coherer instead of consuming its own energy in crossing the relay winding circuit which is closed for the alternative current. (figure 7)

The oscillations induced by the radiation coming from the oscillator on the kko strips on the aerial conductor W, which acts as a resonator, act on the sensitive tube. This action consists, as I said in considerably increasing the conductivity of the tube; so the circuit is closed and the battery current makes the relay work.

The relay in turn passes the current of another larger battery r through the hammer or switch through the electromagnets of the recording device h.

The hammer or vibrator is arranged so as to strike the pipe and shake the filings contained in it. If, at the time these various operations take place, the electrical oscillations on the resonator have ceased, the impact or shock given to the tube by the hammer or will bring back the filing to its normal state of high resistance, and the recording device will mark a point on the strip; but if the oscillations continue at short intervals, the conductivity acquired by the tube j will be interrupted only for an instant by the percussion of the vibrator and immediately re-established by the electric waves; then the

The practical result is that the receiver works as long as the key in the transmitting station is lowered. For each short signal, the relay armatures and the hammer come into rapid vibrations dependent on each other. In fact, it is the relay that, when it comes into operation, makes the hammer work, but this with its action interpolates the relay.

The armor of the Morse recorder is rather heavy and has a relatively considerable inertia; it cannot therefore follow the very rapid vibrations of the relay tongue, but remains at the bottom for as long as the rapid intermittent action of the current in the receiver lasts. In this way the armature of the writing stylus exactly reproduces the movements of the transmitter key, line by line, point by point.

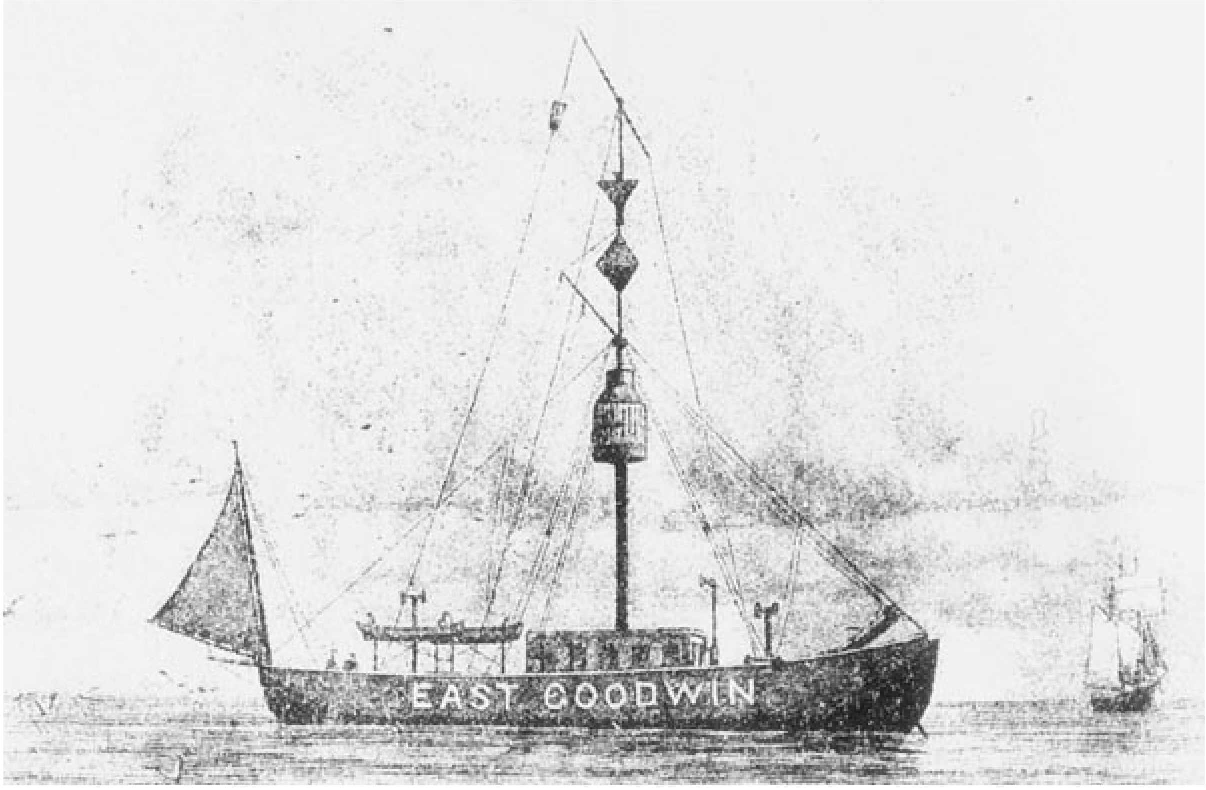
It has been stated that the coherents are of uncertain and unstable functioning, but I must confess that I have never seen this in my experiences. If the coherent is well constructed and used in a suitable receiver, it works just as safely and as smoothly as any other electrical device, such as an electromagnet or an incandescent lamp.

I have cohesives built three years ago that work just as well today, if not better than they did then. I also have tubes that have been running for months in very important installations without ever causing any inconvenience. In the station erected by my company at the South Foreland lighthouse which, as you know, works in connection with the East Goodwin lighthouse boat, the coherent was mounted in the receiver in December last year, when we started the work, and it always continued to function in the most satisfactory way.

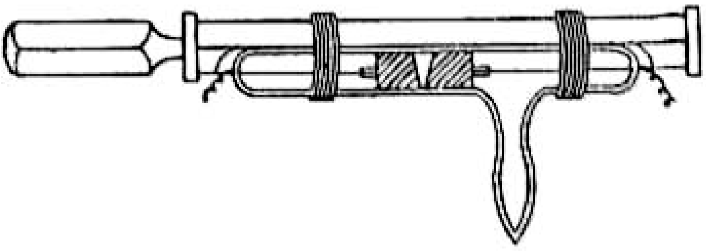
I call your attention to the purpose and function of the vertical conductor W. It is thanks to its addition to the set of devices that it has been possible for us to transmit telegrams at great distances, so far, I believe, to be able to assert, never reached by all other methods of telegraphic transmission through space. The way in which I came to determine the importance of adding the W conductor and the ground connection E to the appliances was as follows:

(I take this information from a copy of a letter I wrote to Mr. Preece in November 1896).

When in 1895 I carried out a series of experiments in Italy, I used an oscillator with one pole grounded to the other connected to an isolated capacity, while the receiver was also grounded and connected to a similar capacity. The capacities consisted of cubes of tinned iron of thirty centimeters side, and I noticed that when they were placed at the top of a pole 2 meters high, it was possible for me to transmit the signals at a distance of 30 meters. With the capacities at the top of 4 meter high poles I could receive the signals 20 meters from the transmitter and with the same cubes placed 8 meters above the ground, while keeping the rest unchanged, they arrive easily at a range of 400 meters. Using larger cubes, of cm. 100 on the side, fixed at a height of 8 meters, clear signals could be received in a radius of 2400 meters, corresponding to about a mile and a half. These results seem to indicate that a transmitting device and a receiver device realized according to the scheme of Figure 1, that is a Hertzian type radiator with grounded pole and the other connected to a vertical or almost conductor, or to a capacitive surface placed at a certain height, and a resonator consisting of a suitable receiver with the terminals also connected one to the ground and the other to an isolated vertical conductor,



The East Goodwin lighthouse boat on which Marconi's appliances are installed.
The antenna is suspended from the mast.



(figure A) Coesore or Coherer by Guglielmo Marconi.

As can be seen, between the two silver electrodes that form a small V-shaped gap,
there is a very small amount of metal dust. Marconi in 1894 - to begin with - observed
how by reducing the quantity of fine metal powder to a minimum,
the sensitivity of the detector became greater.
The glass tube is welded to obtain a slight vacuum; its diameter is 5 mm.

From the Conference given by Marconi to the Royal Swedish Academy of Sciences, Stockholm, 11 December 1909, on the occasion of the conferment of the Nobel Prize to Marconi and Braun.

"The findings related to the propagation of electric waves over long distances and applications of telegraphy through space, who have given me the great honor to share the Nobel Prize for Physics, are largely the consequence of each other.
The the use of electric waves for wireless telegraphic communications between distant regions of the Earth, and the experiences, which I was fortunate enough to be able to perform on a larger scale than can be obtained in ordinary laboratories, have made it possible to study phenomena and to see often new and unexpected results.
I believe that many phenomena, which occur in the transmission of electric waves over great distances, have not yet had a satisfactory explanation, and I propose to expose to you in this conference some observations, which seem to deserve the attention of physics scholars.
In briefly tracing the history of my contribution to the creation of radiotelegraphy, I must say that I have never studied Physics and Electrotechnics in a regular manner, although since he

was a boy he had the greatest interest in these subjects.

I have, however, followed a course of lectures on Physics held by the late prof. Rosa in Livorno and I can assert that I kept diligently informed of all the publications of that time relating to scientific topics including works by Hertz, Branly, and Righi.

In my home near Bologna, Italy, since 1895 I undertook tests and experiences aimed at establishing whether it was possible to transmit telegraphic signals and conventional signals without the need to connect by wire. After some preliminary experiences with the Hertzian waves I quickly became convinced that, if it had been possible to transmit and receive these waves to other similar waves safely and at great distances, a new system of communications would be realized with great advantages compared to the flashes of light and optics, the practical use of which is so dependent on favorable weather conditions.

In my first tests I used a common Hertz oscillator and, as a detector, a Branly coherent; but I soon realized that Blanly's coherent was too unstable and safe for truly practical use.

After some experiences I discovered that a coherent, constructed according to the scheme represented in figure A and consisting of a filing of nickel and silver placed between two silver stoppers in a tube, was remarkably sensitive and safe. This improvement and the fact that I had inserted the coherer in a circuit tuned to the transmitted wavelength allowed me to gradually increase about a mile away at which I could operate the receiver.

Another expedient, now very well known, to which appeals consisted of inserting the coherer in a circuit with a voltaic cell and with a sensitive telegraphic relay operating another circuit which operated a hammer or vibrator. With a Morse key inserted in one of the oscillator or transmitter circuits it was possible to emit successive short or long electric waves, which operated the receiver at a distance and allowed to reproduce exactly the telegraphic signals transmitted through the space by the oscillator.

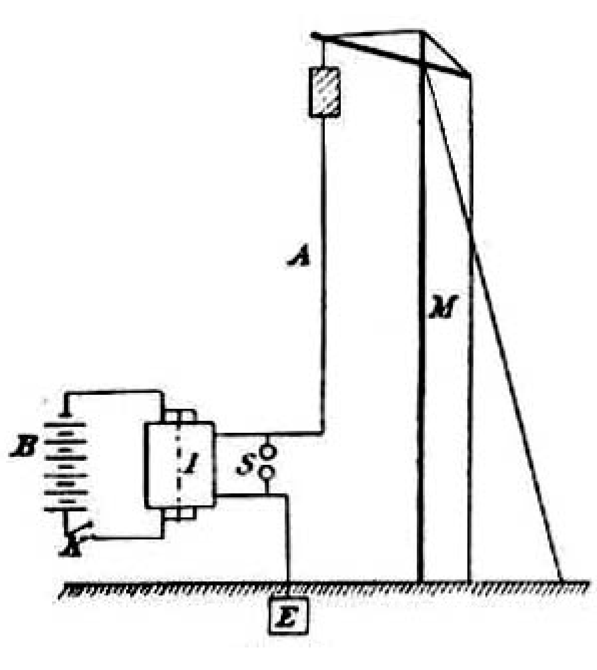
With this device I could wire at a distance of about half a mile.

Some improvements were obtained by using reflectors for both the transmitter and the receivers. At the time, I used Righi's oscillator as a transmitter.

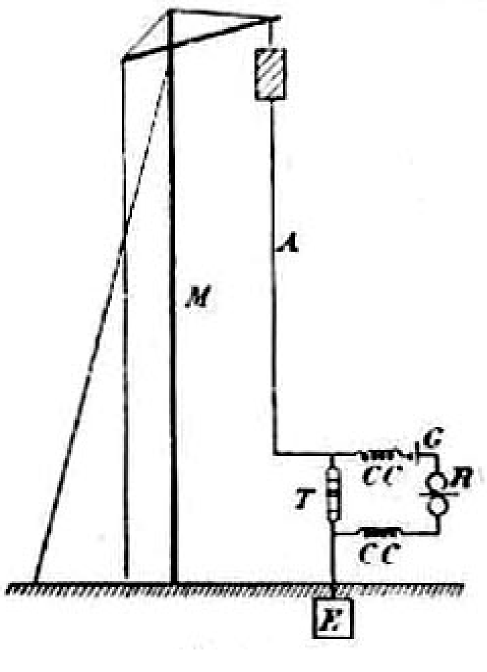
These changes made it possible to send signals in a defined direction, but they proved to have no effect if large obstacles or hills were found to be interposed between the transmitter and the receiver.

In August 1895 I discovered a new device that not only greatly increased the distance I could communicate, but also seemed to make the transmission independent of the effects of the interposed obstacles.

In the new circuit, one of the Hertz oscillator terminals or spark producer was connected to earth and the other to a conductor or to a capacitive surface placed at a certain height above the ground; also at the receiver one of the coherent terminals was connected to the earth and the other to a high conductor. (figure B & C)



(figure B)



(figure C)

I then began to study the reaction between the distance at which the transmitter could operate the receiver and the height of the capacitive surface above the ground; I could soon establish with certainty that the higher these surfaces or conductors, the greater the maximum distance at which I could wire.

I thus realized that, using as capacitive conductors or capacitive surfaces of tin cubes of about 30 cm on the side, placed on poles 2 meters high, I could receive the signals at a distance of about 30 meters, If instead I placed the cubes at 4 meters high I received about 100 meters, if I placed them at 8 meters I received at 400 meters.

With cubes larger than 100 cm on each side at a height of 8 meters, signals could be transmitted at 2400 meters in all directions.

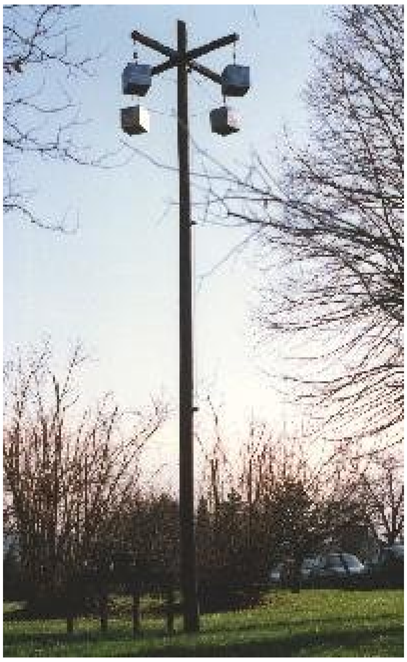
These experiments were continued in England, where, in September 1896, a distance of 1 and 3/4 miles was covered during the experiences carried out in Salisbury on behalf of the British Government. In March 1897 the scope of the communication was increased to 4 miles, and in May of the same year to 9. Some messages recorded on strips, transmitted during these experiences and signed by the British Government officials, who assisted them, are exposed here.

For all these tests, low power electricity was used: the high voltage current was in fact produced by an ordinary Ruhmkorff reel. The results obtained aroused the greatest interest of the public, judging that the flow rates obtained were already noteworthy.

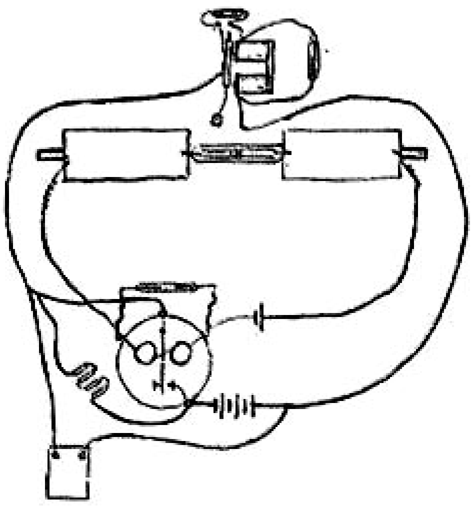
As I have already explained, the main feature of my system was the use of high capacitive surfaces or antennas connected to one of the high frequency oscillator terminals and receivers, the other terminal being connected to earth.

The practical value of this innovation was not understood for a considerable period of time by numerous physicists and the results I obtained were erroneously attributed to the accuracy in the details of construction of the receiver and to the use of considerable amounts of energy.

Others did not overlook the fact that a radical change had been introduced bringing these high capacities from the soil and the earth to be part of the high frequency oscillators and receivers. "...

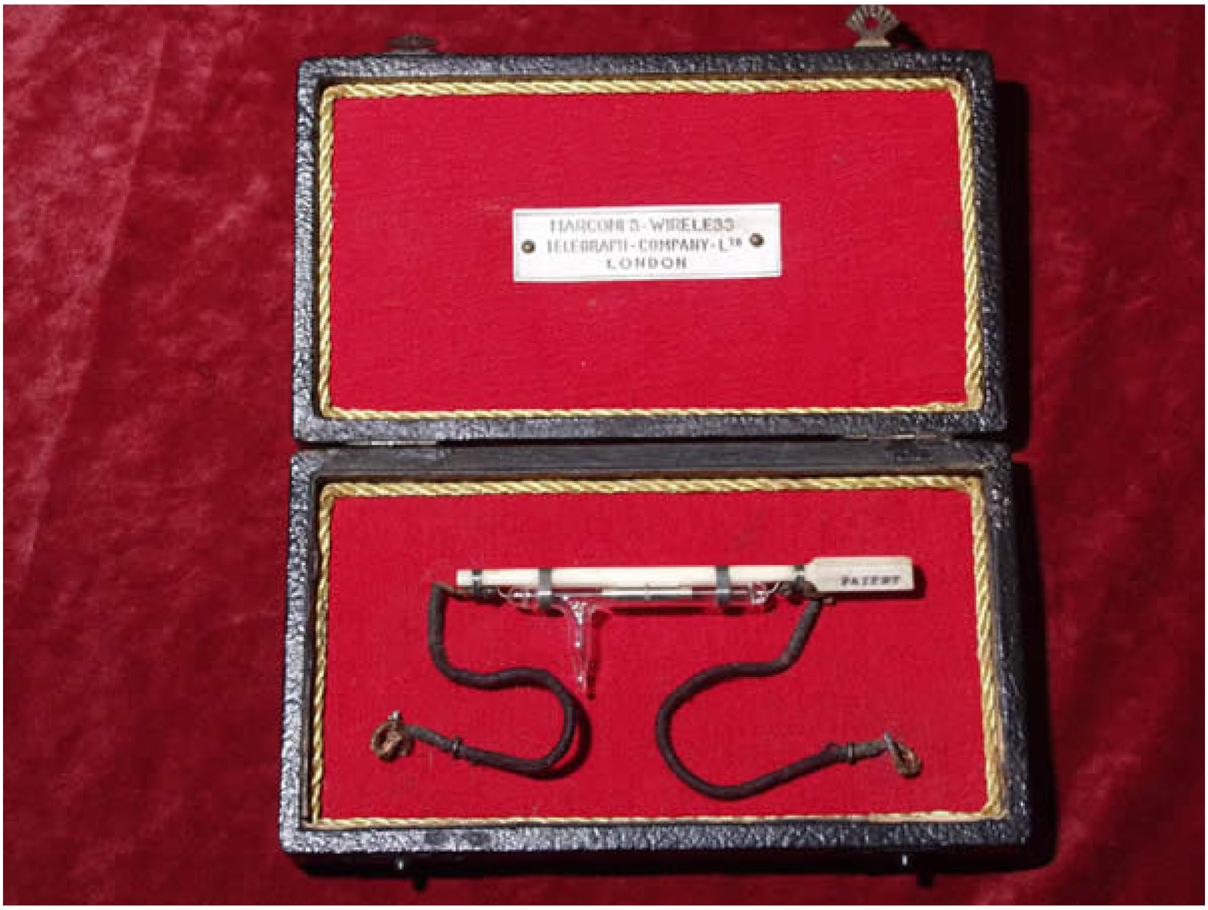


Description of the antenna made by Marconi himself in the Nobel conference
held at the Royal Swedish Academy of Sciences, Stockholm, 11 December 1909.
Reconstruction of the antenna used by Marconi in the famous experiment of 1895,
when the radiotelegraphic signal launched by Villa Griffone passed the hill of Celestini



Schema di uno dei primi ricevitori a coherer realizzato da Marconi nel 1895-1896. Si possono osservare dei piccoli voltametri in derivazione ai dispositivi che compongono il ricevitore Marconi.

Diagram of a device designed by Guglielmo Marconi himself



An original Coherer by Guglielmo Marconi

Speech read before the Royal Academy of Sciences in Stockholm, 11 December 1909. (English)

Speech read before the Royal Academy of Sciences in Stockholm, 11 December 1909. (Italian)

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